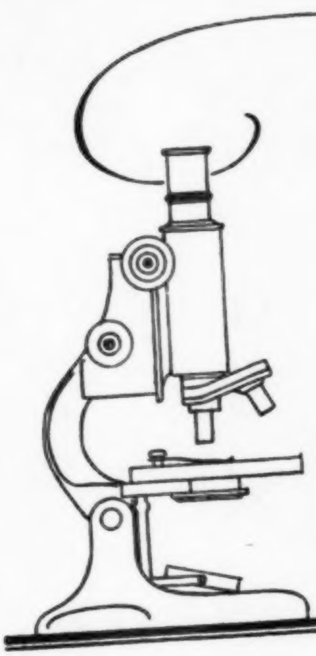

The SCIENCE COUNSELOR

A Quarterly Journal for
Teachers of Science in
the Catholic High Schools

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MARCH, 1935

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The Science Counselor

A QUARTERLY JOURNAL *of teaching methods and scientific information for teachers of science in the Catholic high schools. Published at Duquesne University, Pittsburgh, Pennsylvania, in March, June, September and December by*

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Vol. I. MARCH, 1935 No. 1

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Greetings . . .

"I am delighted with the outline of your procedure and of the field you mean to cover in your new publication, "The Science Counselor." I am certain you will have a demand for it that will surprise all of you. It will reach a public sadly in need of such a journal, and will find readers not alone in the laboratories, but in the Letters courses among classical students and in the Seminaries. Too many of our men and women are coming from our schools today who lack even a hazy knowledge of what has been done in the field of science in the last decade or two. I wish your venture a great success."

MOST REV. HUGH C. BOYLE, D.D.,
Bishop of Pittsburgh.

"Every high school teacher of science will welcome the Science Counselor. We have periodicals designed to help the teachers of other high school subjects, but the teacher of science has been forced to tread the way almost alone. The Science Counselor will freshen the interest and stimulate the zeal of all those engaged in this important field."

REV. PAUL E. CAMPBELL, Litt.D.,
Supt. of Parish Schools, Diocese of Pittsburgh.

"Through the Science Counselor we hope to stimulate and assist the teachers of science in the Catholic high schools and to encourage them in their worthy efforts to raise the level of science instruction in our secondary schools. We feel sure that those for whom this journal is intended will enjoy, appreciate, and support this new venture in the field of scientific literature."

VERY REV. J. J. CALLAHAN, C.S.Sp., LL.D.,
President, Duquesne University.

With the Editor

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THE SCIENCE COUNSELOR is a journal of teaching methods and materials for instructors in science at the high school level. Its title tells its purpose.

There are now many excellent teachers of science in the Catholic secondary schools. The courses they conduct are already admirable. But every teacher will agree that there is no high school—or college either for that matter—in which instruction in science cannot be improved.

It is recognized that teachers of science in the Catholic high schools often work under great difficulties. Undoubtedly there are times when they would appreciate friendly encouragement, advice, and direction. They would be grateful, too, for an occasional stimulus to their enthusiasm which naturally flags at times. Teachers are always striving to increase their knowledge of their field of specialization. They realize that their educational horizons should be progressively enlarged, for their work demands breadth of learning as well as depth. Up-to-date and authentic scientific information must be sought constantly. Teachers of science should be encouraged to test new and different methods of instruction. They will gain much by learning what other science teachers are doing. In their turn they should give to others the results of their own experience. In this way it should not be difficult to arouse a group consciousness and a cordial spirit of cooperation. THE SCIENCE COUNSELOR hopes to help in this work. Its pages will provide a convenient medium for the exchange of information and for the discussion of teaching and administrative difficulties.

Science moves fast. Teachers in service find it difficult to keep up with its advances. Time, facilities, finances are limited. There are many conscientious high school instructors who may not be acquainted with the latest and most important books in science and education. They may not be in touch with recent researches. They are sometimes unaware of the many helpful articles that appear in the current literature. They may not know where to obtain information and materials that could be of service to them in their work.

High schools are not elementary colleges. High school science should never become again what it once was, condensed and abbreviated college science. Modern high school science has aims and objectives of its own, quite different from those of college science. The needs of young people of high school age are not met, and their interest is not stirred, by college science, with its rigid, formal, and abstract didacticism, its logical groupings, its highly technical terminology, its emphasis upon laws and principles, its stress upon laboratory work and the technique needed for research, and its general aloofness from the things that seem important to adolescent youth. Too frequently, however, the instructor fails to appreciate the situation. Unthinkingly he offers to his classes his own college courses, almost identical in material and method, but in an attenuated form. Surely such a teacher is not aware of the developments that have taken place in his field during the past decade.

Some instructors who are well informed in the sciences fail because they continue to use antiquated and unsatisfactory methods. All teachers, of course, want to teach well. Some are more successful than others. The successful ones are those who realize that good teaching doesn't just happen. It must be striven for, prepared for. Good teaching is planned teaching. It is an art rather than a science, but there is no reason why the methods of good teachers cannot be analyzed and studied and adapted to the needs of those who are less successful. Methods in themselves are of little value. Every method, regardless of its worth, requires a real teacher to make it effective. Good methods can make a better teacher out of a good one; they can make the difference between success and failure for the beginner. Teaching methods in any science should be as modern as the subject matter.

THE SCIENCE COUNSELOR hopes to help teachers by bringing to them authentic scientific information before it reaches the textbook stage. It will call attention to modern and successful teaching techniques. It hopes to give its readers a progressive point of view; to inspire them to a careful and scientific study of their own problems; to encourage them to analyze and improve the teaching methods they use every day. The staff of this magazine will be glad to help them to cooperate in solving their common problems and to assist them in evaluating and applying the results of researches. The combined efforts and resources and influences of the teachers of science in the Catholic high schools can be both powerful and productive.

This journal will not be in any sense provincial. Its scope will be national. Among the contributors to its columns will be teachers and administrators in the public as well as in the Catholic high schools, experts in science and in teaching, and instructors and executives drawn from numerous colleges and universities throughout the United States. THE SCIENCE COUNSELOR cannot accomplish what it plans to do through the efforts of any special group. All must help. The aid of everyone who can assist in making it a better and more practical journal will be most welcome.

The success of THE SCIENCE COUNSELOR rests in the hands of the hundreds of teachers of science in the Catholic high schools of the United States. The Editor believes that their response will be cordial and immediate.

The Teaching of Evolution in Catholic High Schools

• By Rt. Rev. George Barry O'Toole, Ph.D., S.T.D., *(Urban University, Rome)*

"There can be no objection, whether scientific or theological, to the acceptance of organic evolution as a WORKING HYPOTHESIS . . . *As such, we are entitled to make use of it, though we must never allow ourselves to forget that it is nothing more than one possible interpretation of anatomical homologies and not a certain conclusion issuing with logical necessity from the facts themselves."*

The present paper aims at answering the twofold question: Whether and in what sense the doctrine of organic evolution may be taught in Catholic schools. The first step will naturally be to define our subject.

Ambiguity of the Term

Evolution is a word to which usage past and present has attached various meanings. Says H. W. Joseph: "I take these (i.e. the terms 'development' and 'evolution') as equivalent, because I believe that 'evolution' is meant now in the sense of 'development', though in pre-Darwinian times it was applied to the doctrine of pre-formation, according to which the chick was present fully-formed in the egg-shell, and its growth was only getting bigger"—i.e. consisted in mere increase of size, not in a true development, which involves change of structure. (*The Concept of Evolution*, 1924, p. 12.)

But in modern usage, too, the term is viciously elastic, being freely used not only in the senses of biological and psychological development, but simultaneously in the sense of physico-chemical transformation and even of mere mechanical change. Nowadays evolution may mean any serial phenomenon from embryological development to the formation of stars and planets; from atomic disintegration to the progress of human science and civilization. To make things worse, mechanistic philosophers are prone to contend that this shifting of the term's denotation involves no equivocation whatever, but reduces itself to the purest univocation. To quote *in re* J. S. Huxley—a citation from John Dewey, or any other modern monist, would have served equally well—all discords are resolved in the formula: "Matter, life, mind, this is the simplest classification of phenomena. By means of processes analogous to obtaining a resultant by the parallelogram of forces, we can obtain a resultant of material operations in general, vital operations in general, and mental operations in general, numerous and varied in direction though they be." (*Essays of a Biologist*, p. 264).

In fine, so hopelessly ambiguous has the term *evolution* become that we cannot even mend matters by adding the specification "organic" or "biological." These adjectives have long since "ceased to qualify the substantive. It (is not) . . . the name of one species of a process . . . but merely of one instance of a process going on everywhere through all history." (Joseph, *op. cit.*, p. 10.) In other words, the monists by mechanizing the significance of this word, have robbed it of all definiteness and voided it of any intelligible meaning.

Transformism and Fixism

To put bounds, then, to the boundless, let me say once for all, that, in the present paper, the term *organic evolution* is used to denote the biological hypothesis, more properly called Transformism.

Transformism is opposed to the Linnean theory of Fixism, according to which the various species of existing plants and animals have persisted substantially unchanged in type from the time of their origin or "creation" (as the initial formation by the Creator of living organisms from inorganic matter is improperly called by scientists unacquainted with precise theological terminology). It should be noted, however, that the theory of Fixism excludes only *specific* change, that is, the transformation of one species into another; it does not exclude *varietal* change, that is, heritable modifications confined within the limits of a single organic species; much less does it exclude environmentally-induced changes that have no determinate basis in the germ plasm.

The opposite view is taken by those who uphold Transformism or Organic Evolution. They proclaim the essential mutability of organic species and assert that the process of transmutation has not respected the boundaries of organic species. Their hypothesis, indeed, assumes the possibility not alone of specific change (transformation of one species into another), but also of generic change, of ordinal change, and even, in its extreme form (styled monphyletic evolution), of phyletic change. Organic evolution, therefore, may be defined as the hypothesis which regards our present forms of plant and animal life as the modified descendants of earlier forms, understanding by *modified* what has undergone a *specific* change and not simply a varietal one (i.e. a change confined within the species).

The Concept of a Species

What, then, is one to understand by an *organic species?* This term denotes a group of plants or animals presenting a common inheritable type, differing from one another by no major difference, though they may exhibit heritable differences of a minor order. The distinction, however, between major and minor differences refers to the *genotype*, that is, the typical germinal composition or set of genetic factors of a given organism, rather than to the *phenotype*, that is, the group of external or somatic characters (coloration,

shape, structure, size, weight, etc.) in terms of which that organism is described. Thus the apple tree and the pear tree, though so alike in their external characters (phenotype) as to resemble each other more closely than do sometimes two varieties of the same species, are germinally so unlike that they are sexually (i.e. gametically) incompatible to a degree which makes crossing absolutely impossible. Or to take as another instance that cited by Thomas Hunt Morgan from the animal kingdom: "There are two wild species of Drosophila (fruit-fly) that are so much alike externally that they were put in the same species. One is now called D. melanogaster, the other D. simulans. Careful scrutiny shows them to be different in many ways. They cross with difficulty and the hybrids produced are completely sterile." (*The Theory of the Gene*, 1926, pp. 99, 100.)

In short, the specific status of a given plant or animal type cannot be determined on the mere basis of external characters. Hence Bateson, following John Ray (1628-1705), "the Father of Taxonomy," lays down as an essential qualification of a species that all the individuals belonging to it should be perfectly-interfertile with one another, but incapable of producing other than sterile or semisterile hybrids if crossed with the members of another specific group. When a character-difference, though inheritable, is not such as to involve *intersterility* of the differing types, that difference is minor, not major; varietal, not specific: it does not preclude both forms belonging to the same organic species. A difference that does not impair interfertility is basis sufficient indeed to warrant the segregation of a new variety, but not of a new species. "The chief attribute of species," as William Bateson observed, "is that the product of their crosses is frequently sterile in greater or less degree." (Toronto Address, *Science*, Jan. 20, 1922, p. 58.) To this primary qualification we must add that of *viability* and *hardiness*, the further requisite, to which David Starr Jordan wisely drew attention. A genuine specific type must be capable of indefinitely prolonged survival in the wild state, apart from the protection of human artifice. A form that cannot hold its own in nature has, to use Jordan's own words, "no taxonomic value." "A complete definition of a species," says he, "involves longevity. A species is a kind of animal or plant which has run the gauntlet of the ages and persisted." (*Science*, Oct. 20, 1922, p. 448). Hence a change, even though inheritable, that tends to weaken the vigor or diminish the fecundity of the changed organism, has not produced a normal species; its product is a degenerate form or subnormal type, incapable of survival apart from artificial conditions.

Specific Change

What then, is the critical test of specific change? The observed origin of a new, heritable, viable, and fertile type which, if back-crossed with its parent-stock, produces sterile or semisterile hybrids. This alone can constitute a scientific verification of evolution as a process actually at work in the organic world. Without this piece of evidence the case for evolution is essentially incomplete. The verification of fixism, on the contrary, must necessarily be negative and indirect. From the very nature of things, it cannot be proved except by disproving its contradictory, namely, the transformistic contention that one species can change into another. Its vindication can only come with the complete collapse of the best case natural science can make out for transformism. Meanwhile, it is important to remember that here we deal with a problem entirely within the competence of natural science to settle; it is outside the province of ecclesiastical authority to render any verdict on the matter.

The Autonomy of Natural Science

The notion is unfortunately current among non-Catholic scientists that the Catholic Church is hostile to the autonomy of natural science and aims at substituting authority for research. Nothing could be farther from the truth. As a matter of fact, the Church positively insists on the autonomy of philosophy and the natural sciences. Nor need one seek far to find the reason. To begin with, the Church cannot expect men to receive her revealed doctrines unless she is in position to prove the reasonableness of faith by demonstrating its preambles and presenting solid motives of credibility. But, in order to serve their purpose as *arguments of credibilty*, such proofs must rest on the *basis of natural reason alone* and may not *presuppose faith;* otherwise the whole procedure becomes *a vicious circle*. On the other hand, from the very nature of things, the Church must draw her "arguments of credibility" from philosophy, natural science, and history; and the whole value of such arguments depends on their being established with certainty upon *exclusively natural and scientific grounds*. Hence, unless philosophy and science were bound to verify their conclusions through independent inquiry and research, Revealed Religion could not appeal to their conclusions as "arguments of credibility." Hence it is most vital to the Church that philosophy and science should stand on their own legs and not on those of religion. And thus it came to pass, as Cardinal Mercier remarks, that "when in the first half of the last century De Bonald and La Mennais sought to oblige human reason to receive its first principles and its primary motives of certitude from revealed teaching, Gregory XVI, far from accepting this dutiful subjection, publicly reproved and condemned the mistaken loyalty of its authors . . . In short, philosophy and the sciences are autonomous in this sense that in their case the supreme motive of certitude is the intrinsic evidence of the object they study, whereas in matters of faith the ultimate motive is the authority of God, the author of supernatural revelation." (*Scholastic Philosophy*, Eng. version, vol. I, pp. 22, 23). Such is the legitimate independence which the Church herself vindicates for natural science. Naturally, however, it is not an irresponsible liberty; not a license to cheat in the presentation of scientific facts (as Ernst Haeckel did, upon his own admission). Neither is it any warrant for undermining the fundamentals of religion through rash and hasty judgments,

Continued on Page Twenty-two.

An Amateur Looks at the Stars

Through Her Own Home-made Telescope

The Experiences of
• Sister M. Cornelia, O.S.B., B.S.,
(Duquesne University)

A nun interested in rouge and powders and mirrors? Yes, indeed, and not ashamed of it! But the powder and rouge are not cosmetics, and the mirrors are not the usual kind. The mirrors are made by hand at home, by a long and careful process that would discourage anyone but an enthusiast. The rouge and powder are for grinding and polishing. These articles all have to do with the building of a telescope, a project that most teachers believe is far beyond their capabilities. They are wrong.

Millions of people have never even observed the stars through a telescope. Thousands have telescopes of their own. But only a handful of persons have experienced the delight and gratification that come from using a powerful instrument of their own construction. Sister M. Cornelia, O.S.B., of the Immaculate Conception High School, Connellsville, Pa., is one of the fortunate few.

Sister Cornelia's interest in telescope building began one evening more than a year ago when four members of the Amateur Astronomers' Association of Pittsburgh brought to the Motherhouse their home-built telescopes to give some of the Sisters their first glimpse of Saturn's rings, Jupiter's satellites, the craters of the moon, and other wonders of the skies. All the Sisters marveled at what they saw, but one of them was more interested in the instruments than in what they revealed. To Sister Cornelia came the daring and ambitious idea of constructing a similar telescope of her own. Soon the amateur astronomers were busy answering her questions about mirrors, lenses, grinding powders, polishing rouge, finders, focal length, curvature, and other practical details. A good training in science enabled her to understand their somewhat technical replies. Her enthusiasm grew. Sources of supplies, apparatus and costs were discussed, and she was not discouraged. Before the evening was over, two of the amateurs, Messrs. Leo J. Scanlan and Leo Schoenig, had promised Sister Cornelia that should she attempt to make an instrument they would advise and assist her in the work. They kept their word. The telescope was built. The few minutes at a time that could be spared from religious exercises and class instruction were utilized. The work progressed slowly, but after a period of labor extending over several months, the telescope became a reality and Sister Cornelia had the thrilling pleasure of examining the glories of the heavens through an instrument her own hands had fashioned.

It is evident, then, that the building of a telescope is not too difficult for a Sister to undertake and carry to successful completion. Neither is it beyond the skill of high school students. Some of Sister Cornelia's pupils in physics are now grinding mirrors for their own use. The work requires time, energy, patience, persistence, some reasoning ability and a little manual dexterity. Although this hobby is an inexpensive one, it brings rich rewards.

The instrument built by Sister Cornelia is a Newtonian reflecting telescope, the kind commonly selected by amateurs because it is simple, cheap, easy to make and highly satisfactory. A cylindrical or hexagonal tube of sheet metal is mounted on a metal base. Both tube and standard can be made cheaply by a tinsmith or plumber. A wooden tube will serve, or even one made of the very heavy cardboard used for packing linoleum. The one essential is rigidity. After the tube has been painted black on the inside, it is fitted with a finder, eye-piece, prism, and, most important of all, a good reflecting mirror. When parallel rays of light are received down the tube from a star or other distant object, the mirror reflects them so that they will produce an image at the focus of the mirror. Before they reach the focal point, however, they are intercepted by a properly located glass prism which reflects the rays to the eye-piece on the side of the telescope tube, where they are examined with a lens.

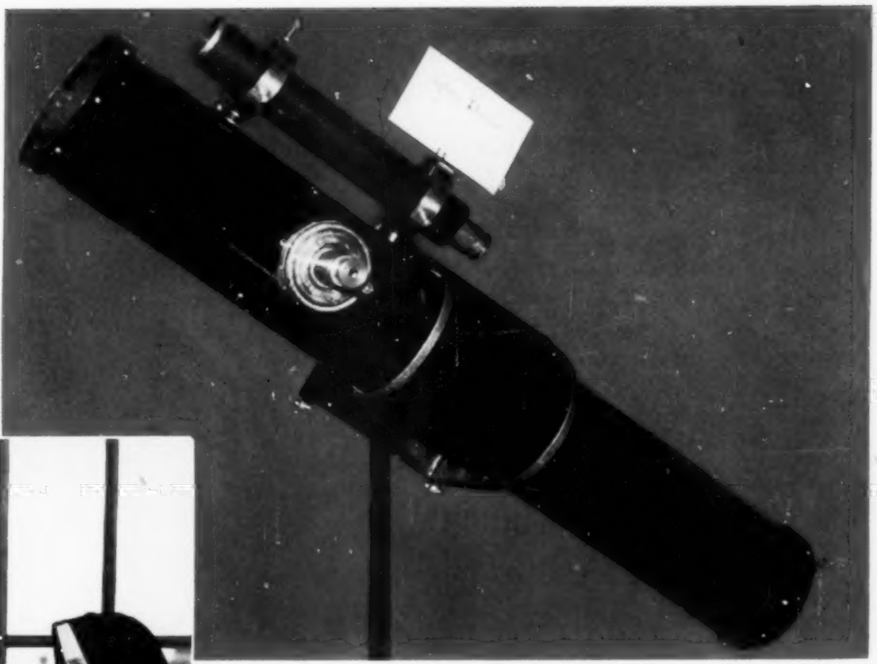
A low power ocular from a microscope makes a good eye-piece. The one-inch, 90°, glass prism is not expensive. Many amateurs do not use a finder. It is not an essential part of the instrument, but rather a refinement which assists the observer in locating quickly any terrestial object or special star that he desires to examine. The finder is merely a small telescope fastened to the outside of the tube near the eye-piece.

Most of the labor required to make a telescope goes into the fashioning of the reflecting mirror. Great care must be exercised in its grinding, polishing, and testing—for the telescope cannot be a good one if the mirror is unsatisfactory. On the other hand, a good mirror makes a good telescope. It is extremely difficult to make a good mirror of large diameter. Sister Cornelia, as a learner, was advised to make one six inches in diameter. This is the usual size for beginners, for even such a small one will furnish enough troubles to test the worker's determination and perseverance.

A beginner's mirror-kit, containing two thick, flat, circular glass disks six inches in diameter, and the grinding and polishing powders and other materials required for making the mirror, was purchased for $5.00. Two glass disks are furnished so that one may be used to grind the other into the desired shape. The flat surfaces of the disks are placed together with moistened carborundum abrasive powder between them.

Continued on Page Twenty-nine.

The Work of Amateurs



● ABOVE

Reflector telescope built by Edward A. Yochum, a sophomore student at the St. Justin High School, Pittsburgh.

● ABOVE

Sister M. Cornelia, O.S.B., demonstrating the use of the telescope to three students of her physics class. This is the telescope that Sister Cornelia constructed. These young men are now grinding mirrors for the telescopes which they are building for themselves.

● BELOW

Sister Cornelia shows one of her girl students how to grind a mirror. This young lady is at work on an eight-inch mirror.

The Interdependence of Plants and Animals

• By Dolores Guehl, *Annunciation High School, Pittsburgh*

This essay won the first prize in a contest for high school students conducted in connection with the Conference for Teachers of Science in the Catholic High Schools, recently held at Duquesne University. Honorable mention was given to Jean Hickey, Lourdes Academy, Cleveland, O.; Martha Ann Whelan, Villa Maria High School, Villa Maria, Pa., and to Theodore Obendorfer, Ursuline High School, Youngstown, O.

"How would the world ever get along without me?" remarked a regal lily once upon a time, proudly tossing its haughty head. The answer is that the world would doubtless get along very well without this one plant, but would it fare as well if there were no green plants at all? The answer to that is a very decided "No"; for plants and animals are dependent upon each other for their existence.

There are three cycles that show how closely living things depend upon each other. They are the carbon cycle, the oxygen cycle, and the nitrogen cycle. Let us first consider carbon, which is an essential part of all living matter.

The carbon in our bodies is derived from the fats, proteins, and carbohydrates which we eat. These come from either plants or animals. Plants get their carbon from the carbon dioxide in the air. How does carbon dioxide get into the air? All living things take in oxygen and eliminate carbon dioxide. Animals exhale a large quantity of carbon dioxide and inhale much oxygen. Plants need little oxygen but consume a great deal of carbon dioxide which is decomposed in the plant, the oxygen being given back to the air, and the carbon retained in the plant. Combustion furnishes additional carbon dioxide to provide raw material for plant food.

Thus we see that our lives are dependent upon the activities of green plants; and the existence of plants is made possible by the carbon dioxide exhaled by animals. If the amount of animal life should greatly diminish, the growth of plants would be affected by the lack of carbon dioxide. Likewise if the amount of plant life should decrease greatly, the growth of animals would be halted because without plants there would be no carbohydrates.

Since all living things are constantly drawing upon the supply of oxygen in the air, its quantity is limited. Once oxygen has been used in the oxidation of organic matter it is no longer available for similar use. If all green plants should suddenly cease their activities, the amount of carbon dioxide in the air would steadily increase and, correspondingly, the supply of oxygen would decrease. Soon the maintenance of animal life would no longer be possible. However, through photosynthesis, which is the process of carbohydrate formation, oxygen is liberated, and becomes available once more for the use of animals.

We now come to the nitrogen cycle. In the case of nitrogen, man's dependence upon living things is very marked. Plants take water and minerals from the soil in which they grow. The water thus drawn from the soil is replenished by rain. In the manufacture of proteins, plants must have nitrogen in the combined form. They cannot use free nitrogen, such as is found in the air. In the processes which take place in plants and animals, proteins are broken up into simpler nitrogen compounds. Some of these can be used again in making proteins but others disappear in the air and are thus lost from the cycle of life. Nitrogen is the only element that does not automatically return to the life cycle; this presents a serious problem.

It has been found that in some soils there are tiny plants called bacteria which can fix the nitrogen of the air into nitrogen compounds, such as proteins. On the roots of plants of the legume family, such as peas, clover, and alfalfa, are tiny swellings or tubercles in which are found nitrogen-fixing bacteria. Plants of this family contain more nitrogen compounds than other plants. If the size of a crop on a farm diminishes because of a lack of nitrogen, it is only necessary to plant a crop of peas or clover. During the summer the tubercles on the roots take in a large quantity of nitrogen from the air. Part will be used in making proteins; part will be taken by the roots of the plant on which they grow; and in the end there will be in the soil much more nitrogen in a combined form than there was at the beginning of the summer.

DOLORES GUEHL

Miss Guehl, who is 17 years old, will be graduated from Annunciation High School in June, 1935. She has led her class for four years.

The interdependence of plants and animals has been shown in the three cycles, carbon, oxygen, and nitrogen. We can thus see that animals could not exist without plants, nor plants without animals.

Physiology in the Secondary Schools

● By Herbert H. Sullivan, B.S., M.D., *(University of Pittsburgh)*
IN COLLABORATION WITH
William A. Schubert, A.B., M.S., *(University of Pittsburgh)*

Is physiology a neglected subject? The writers believe that physiology should be taught as a distinct and separate study; it should be placed late in the course; and it should be well taught by a properly qualified teacher. You may not agree with all their ideas.

●

Too often, I believe, physiology is neglected in our high schools. This important subject deserves more attention and consideration than is now being given to it. In my opinion it should be placed on an equal footing with the other high school sciences.

The science of biology includes not only botany and zoology, but also physiology, hygiene, anatomy, bacteriology and other subdivisions. In the secondary schools, however, I am afraid emphasis is commonly placed only upon botany and zoology. Physiology suffers especially. Most high schools have no separate course in this subject. The little physiology that is offered, is given in connection with the second-year course in general biology or in a superficial course in "health education." As a physician and as an educator I maintain that physiology should be taught as a distinct and separate study; it should be placed late in the course, preferably in the senior year; and it should be well taught by a properly qualified teacher.

Why Study Physiology

"The proper study of mankind is man." Now man is a rational animal—a being composed of body and soul. The Church teaches him to care for his soul. It is important, too, that man shall be concerned about his physical structure and its intelligent care. The non-medical public recognizes the practical importance of the study of the human body, but many people still believe, wrongly, that high school physiology must be mainly a discourse on the evils of smoking and strong drink. Physiology teaches habits of good physical living which in turn lead to habits of good moral living. It teaches man to live reasonably, for wrong living brings ill health—sickness of both body and soul.

When properly taught, physiology is a most fascinating as well as useful study. It needs good teacher-salesmen, however, men and women who know their subject, who really can teach, and who will make their courses practical and attractive. The amount of teaching material available is almost unlimited, for physiology studies the functions of the living body and its parts, and concerns itself not only with the simple functions of the single cell, but also with the more involved functions of the multi-cellular tissues such as nerve, bone, muscle and blood. It studies the functions of the heart, liver, stomach and other organs as well as the circulatory, respiratory, digestive, absorptive, nervous and reproductive systems. And finally, it considers the functions of man as a whole, that marvelous finished co-ordination of the being which "God created . . . to His own image."

The subject matter of physiology is so important that especial consideration should be given to its place in the curriculum. It should be taught when it will reach the greatest number of those who can understand and appreciate it. Some of the most interesting and valuable material of this science requires a fairly mature mind to appreciate its importance. Logically, physiology should follow both botany and zoology. It is dependent for its proper interpretation upon a knowledge of physics and chemistry. To get the best results the students, as well as the teacher, should have a good foundation in all these sciences. Senior high school students have a suitable educational background. They are at an age when they are interested in the "why" of life. They are passing through a period when they should have information that is essential to later happiness.

The Teacher

The teacher should have made a special study of the human body. Few high school teachers have more than a theoretical knowledge of physiology. Good college courses in this science are not common. Evidently there is little demand for them. College students seem not to be interested in this science, while the other sciences have many followers. As if by common consent, the serious study of physiology is left to the medical profession. It is true that physiology is one of the physician's tools, but there is no real reason why other competent scholars should shun a detailed study of the human body. Undoubtedly, part of the trouble lies in the fact that physiology has not been made attractive. Physicians have done little to popularize it, possibly because they have been preoccupied with other details of the healing art. They should be more aggressive. Although only a few teachers are able to take advantage of the opportunity, competent non-medical students are usually permitted to attend the courses in physiology at medical schools. The teacher of physiology may use this or any other suitable means to better his preparation. He should strive constantly to increase his own knowledge, for he cannot give to his class what he does not possess. The success of the high school course in physiology will depend largely upon the talents of the teacher in charge; his prepara-

tion and background; his teaching ability and his enthusiasm for his work.

Technique

Careful planning is necessary. Each day's work should be outlined and a definite plan prepared for the whole term. Nothing should be left to chance. There must be careful division of time among presentation, demonstration, quiz, review, and assignment. A poor plan is better than no plan, but even with the best plan, difficulties will arise that will test the patience of the teacher.

Students in physiology may be required to prepare a brief outline of the course, with such carefully labeled sketches and diagrams as the teacher may demand. Essays on assigned topics may be presented by the better members of the class. Visual aids are of great importance. Diagrams, charts, models, photographs, blackboard sketches and lantern slides can be in almost daily use. A manikin is almost indispensable. A balopticon to show pictures, diagrams and reading material from reference books is helpful. When they are available through a hospital connection, nothing succeeds in stirring up interest more than the showing of post-mortem tissues from autopsies, but discretion must be used in their selection and use. Animal hearts, livers and other organs can be obtained from butchers.

Rough blackboard sketches may be made while the teacher talks. Interest in them is greatly increased if colored crayons are employed. Red is used conventionally to indicate the arterial, and blue the venous system. Blue is used also for the sensory portion of the nervous system, while red indicates the motor nerves. Certain simple experiments can be carried out in the biology laboratory and valuable class demonstrations can be devised by the ingenious and ambitious teacher. Muscle and nerve kymograph records can hardly be made in the high school laboratory, nor can animal experiments involving circulation or the nervous system be done; but a number of worth-while experiments can be carried out with little or no apparatus.

Experiments

Reflexes can be tested by the knee jerk, demonstrating, when the reflex is normal, the traveling of the sensory message to the spinal cord, its synapse across to the motor side, and its return to the muscles of the leg. Reflexes can also be tested by pupillary reaction to light and accommodation. Such simple demonstrations as that of the blind spot, and the peripheral field of vision are interesting. The watch-crystal method of timing the clotting of blood, and the effect of the presence of sodium citrate on clotting can be easily carried out. The Schwabach test for hearing upon which certain new devices to aid the deaf are based, can be demonstrated. When a vibrating tuning fork is held at the forehead or between the teeth, the sound is heard all over the head; but if one ear is closed, the sound will be localized on that side, since the sound is not passing through the air to the ear drum and over the chain of ossicles but is carried by nerve conduction through bone direct to the nerve of hearing.

The attention of students should be directed constantly to hygiene, which includes all that has to do with health and its preservation. The hygiene of the city, the neighborhood, and the schoolroom can be studied. Sewage disposal, water supply, plumbing, food handling and preservation, contagion, flies, and the pasteurization of milk make interesting topics. The students may be permitted to prepare diet charts, comparing their own diets with model, balanced diets. Physicians may be invited to address the class and to demonstrate the stethoscope, a blood pressure apparatus and other instruments of interest.

An idea of relative size is important. For example: "A fine hair may have a diameter of 1/500 of an inch. Six red corpuscles, lying flat in a row with their edges touching, would about span the cut end of a hair. It would take a half dozen bacteria of average size, laid end to end, to reach across the disk of a single corpuscle. When the microscope is used, it is a convenience to bear in mind the real size of the visible field. For a magnification of 100 diameters this is usually about 1/20 of an inch; for 500 diameters it is about 1/100 of an inch." (Stiles).

Satisfactory high school textbooks in physiology are scarce. In most textbooks there is an insufficiency of descriptive detail, and it is necessary for the teacher to provide the additional information needed for a fairly complete understanding of the topic. A college textbook of physiology or one used in medical schools will usually supply the required information. Students should be encouraged to consult such references. An elaborate library is not needed. A list of a few useful books is given at the end of this paper.

Discussion should be encouraged on such points as: What is death? How does the intestinal villus absorb food elements? What is the etiology of the various phases of blood pressure? Explanations can be made of the recently proved theory of renal function,—that of Cushny,—to the effect that filtration of the blood plasma takes place in Bowman's capsule of the glomerulus, and that an important reabsorption into the circulation takes place in the kidney tubules, while the unnecessary waste materials, such as urea, are excreted in the urine. Shall no mention be made of the layer of rods and cones of the retina? Is the real end-organ of hearing, the organ of Corti, never to be discussed in high school? Students should not be deprived of the complete story of the sound wave as it travels, first in air, and then through the ear drum and the chain of ossicles. Next it passes through a liquid medium, the perilymph of the internal ear, and on to a liquid of another type, the endolymph, separated from the perilymph by membranes. Bathed in the endolymph, resting on the Basilar membrane in the snail-shaped cochlea, is the organ of Corti—the sensory nerve endings of which convert the physical impulse in the endolymph into a sensation which is carried over the auditory nerve to the brain and there recognized as sound.

Reproduction

Such interesting topics as these can be well understood by students who are more advanced than those

Continued on Page Thirty-one.

Helpful Teaching Devices

● Sister M. Garbriella, O.S.F., B.S. *(Duquesne University)*

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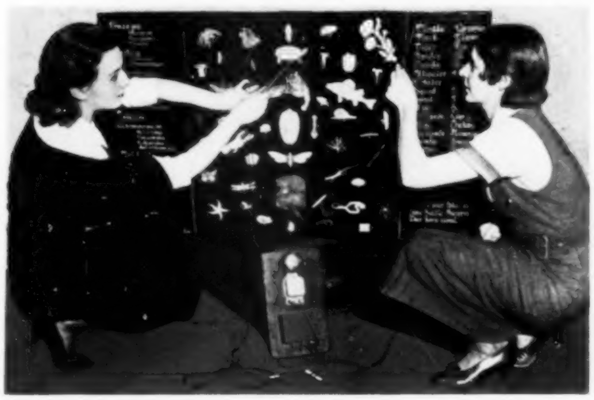
Electric Identification Charts

During their club periods this year the members of our amateur biology club constructed two electric identification charts that have proved valuable for the review of class and club work and for the self-instruction of all who are interested. One chart identified



An electric identification chart.

biologists and their contributions to science; the other was concerned with the identification and classification of animals. The same plan was followed in the construction of both charts.

For the second chart, pictures of animals, procured from books, catalogs and other sources, were mounted in the center of a large sheet of poster cardboard. A vertical column on one side of the chart contained a list of all the animals pictured. A corresponding column on the other side gave the classification of each animal. No set order was followed in arranging either the names or the classes of animals.

After the cards had been prepared and lettered a coating of clear lacquer was applied. We found that the ink of some of the pictures would not stand the lacquer, and a little experimenting was necessary in order to learn which pictures would permit lacquering without smearing.

When the lacquer had dried, short brass "button-top" paper clips were inserted at the side of each picture, each name and each class. On the back of the card insulated wires were connected to the three related buttons of each group. An electric buzzer attached to a four and one-half volt radio battery was mounted on a small board. When the testing pencils attached to the buzzer are applied to any two of the three related buttons, the buzzer announces that the circuit is closed and the identification is correct. Because of the way in which the chart is wired, mistakes in identification cannot be made since the circuit can be completed only by making the proper connections.

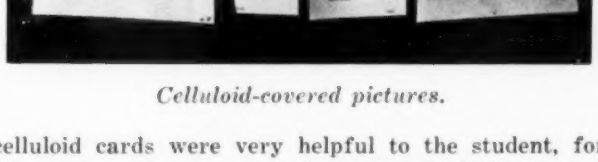
Boys like to make this kind of chart. They like to operate it, too. So do grownups!

Mounted Pictures

When I met my class of thirty girls in September, I knew at once that it was not going to be an easy task to overcome their inherent prejudices against the study of biology. The mere idea of studying "bugs" was repellant to their fastidious natures; but with "bugs" it was necessary that I begin, since insects are so plentiful during this season.

To arouse the interest and curiosity of my pupils and to help mitigate their prejudice, I prepared and used sets of brightly colored celluloid-covered pictures of insects. The pictures accomplished their purpose. They really succeeded in casting at least some glamour and fascination around the unit, "Insects and Their Relation to Man."

We employed these home-made devices not only for discussion and display preceding the study of insects, but also as identification aids later on in the course when we decided to have each student make a collection of fifteen insects. In the work of identification the



Celluloid-covered pictures.

celluloid cards were very helpful to the student, for the names, pictures, and descriptions of the insects made classification of the captured insects easy. The pictures are mounted in such a way that they will survive much handling. They have been filed and will be used repeatedly.

Continued on Page Nineteen.

Have You Contacted Reality?

• By Jerome D. Hannan, S.T.D., J.C.D., *(Catholic University)*

"It is a mark of periods of decadence that scholars content themselves with poring over the past and with expressing its inventiveness in new forms, lacking the originality that pushes into regions unexplored. Any sort of training devoid of laboratory experience is similarly stigmatized."

• •

This article is reprinted, by permission, from the January, 1935, number of the DUQUESNE MONTHLY.

I am still writing with the enthusiasm and hopefulness of one who expects some day to be able to write. Ambition was born in me when I was still unacquainted with the mysteries of psychology and cosmology. I had a hero before my eyes already an initiate in those esoteric realms. What was more, he was regarded as having literary talent in spite of it. I remember how devoutly I wished that when my turn came to roam the regions of philosophy I, too, might be a great writer in spite of it. But the pity and the tragedy of it is that my hero, even though he has long since escaped the thrall that curbed his poetic soul, has not yet become a great writer. And I am still hoping some day to catch up to him.

It is only natural, then, that I should attempt to gratify this aspiration of mine in a quarter where it was first all but too extravagantly nourished. Thus the same magazine* may bear witness, if one consults its pages of twenty years ago, to the tenacity with which the budding literary genius continues to bud and to the unsuspected vitality of the germ of greatness in imaginations not too hostile to its growth.

I would that now I dared venture into the intricate fields of knowledge that then seemed well charted to my inexperienced mind. Alas, even the titles of much that then was written seem inexplicable now, even though they were meant to be simple and succinct suggestions of what followed them. It is evident, then, that it is with no small degree of trepidation that I presume to write for college men. I dare no longer boast familiarity with the labyrinthine passages of knowledge whose convolutions are so easily recognized by them. The titles of twenty years ago persuade me of the extensiveness of their knowledge and discourage me from saying the simple things that now mark the horizon of my competence.

I am wondering whether laboratory experience is still as notable by its absence in the college curriculum as it was during my student days. It is a mark of periods of decadence that scholars content themselves with poring over the past and with expressing its inventiveness in new forms, lacking the originality that pushes into regions unexplored. Any sort of training devoid of laboratory experience is similarly stigmatized. A scholar cramped by the inadequacy of such training is deprived of facilities that are available to even the most stupid apprentice in the shop of a tradesman. If the latter is not too stupid to use his hands, he is surrounded by numerous opportunities that literally demand some sort of practical manipulation. But the scholar too often is confined for his laboratory experience to a more or less expert solution of the riddle made by the fluctuating design of black ink smeared on the textbook page.

"Brain trusters" thus come to have a bad name. Any contractor would rather employ as bricklayer a man who had laid bricks than the most scholarly student who had merely studied how bricks should be laid. Too often a diploma bears written between its lines, "This chap knows only how to study." Thus it is a liability to one seeking employment. For strange as it may seem, practical men of the world are for the most part demanding, not men who have learned how to study, but men who have studied how to do.

Even the man who dedicates himself to research assumes the responsibility of constructive effort. His task is not merely to make compendiums or collections of what his predessors have learned. If he follows the trail they have cleared, it is only with the determined purpose of departing from it somewhere or of following it beyond the boundary previously explored.

It may be accepted at least as an hypothesis that inventiveness depends on new ideas. Even so scholastic an enterprise as trapping two old premises, a major and a minor that have never encountered each other in the past, produces a new coincidence that may often be called a conclusion. Though the child of deduction, and therefore somewhat in disrepute in this modern age, it has the advantage of being younger than those who hate it, and may live to see the day of triumph after its enemies are dead. But a conclusion that has wandered the highways and byways of the schools is chiefly despised because of its decrepitude and infertility. That is hardly a reverent attitude, it must be confessed. For our elders are our earliest moderators, and there are ancient conclusions without whose guidance we wouldn't know the way to a new idea. But if we accept the indispensable aid of tradition to guide us on our way, we must not lose the way for meditating too morosely on our guide.

If you send a messenger to report on the landmarks of a journey, you have made some excursion into the region traversed by him. His reactions to his traveling experiment have given him ideas; perhaps his explanation of them will produce still other ideas in your mind. But go yourself over the route with an attentive

Continued on Page Eighteen.

*Duquesne Monthly.

Homogeneous Catalysis

● By M. A. Rosanoff, Sc.D. *(New York University)*

Some Ideas Concerning Its Nature and Operation

●

Catalysis is so common a phenomenon that a discussion of it scarcely needs to be introduced by a definition. A given reaction, simple enough in its stoichiometric aspect, refuses actually to take place unless a certain foreign substance is present, which remains entirely unchanged either in quantity or in quality. Ammonia and hydrochloric acid form ammonium chloride. But the two reagents, as shown by Baker in 1894, refuse to combine if mixed as perfectly dry gases. A mere trace of water is sufficient to set off the reaction and enable it to run to completion. Water does not appear in the chemical equation. What is the role of the "catalyzing" trace of moisture?

"It will be seen that the elements of our working hypothesis were not novel. Its value and novelty were chiefly in the idea that there was nothing ELSE *to homogeneous catalysis, that therefore catalysis was not at all the dark mystery that it appeared to be."*

One hundred years before Baker, Mrs. Fulhame found that dry carbon monoxide refuses to combine with dry oxygen. Here again moisture is mysteriously required in a reaction that involves no water stoichiometrically.

Often the required "catalyzer" is a solid. Thus, finely divided platinum promotes combustion and plays an immensely important part in industry by hastening the oxidation of sulphur dioxide to sulphuric acid. Finely divided nickel is the catalytic agent of the Sabatier-Senderens reaction and, among other things, transforms for us liquid oils into solid fats, like "Crisco." Metallic iron catalyzes the combination of nitrogen and hydrogen into ammonia, a process of great practical value to agriculture and the manufacture of explosives.

The present remarks will be limited to the liquid state and to those cases in which catalyzer, reagents, and any solvent that may be present mix homogeneously,—in the hope that this theoretical simplification may serve as a first step toward the inauguration of some order within the chaos of the catalysis problem in general.

The classic example of a homogeneous catalytic reaction is the inversion of sucrose. Stoichiometrically, cane sugar plus water give glucose and fructose. In reality this does not occur unless acid is added,—acid which remains unchanged and undiminished in the course of the hydrolysis! What is the nature, what is the mechanism of this catalytic effect of the acid? I will briefly re-state here a working hypothesis developed some years ago, which was corroborated by all of a number of special experimental tests and which is contradicted by no fact that has as yet come to my knowledge.

When attacking a puzzling natural phenomenon, the investigator often takes as his point of departure and as a basis for further discussion, a plausible hypothesis. This does not mean that he will thenceforth devote himself to forcing the facts of observation and experiment to fit his hypothesis (a sin not uncommon in the realm of speculative philosophy?). The hypothesis is merely to guide him in planning systematic experiments instead of searching pell-mell. If the experiments contradict the hypothesis, it is the latter that is forced into agreement with the facts, or else discarded. This is why such a guiding principle is modestly called a "working" hypothesis.

In approaching the catalysis of sugar inversion, we adopted such a working hypothesis as to the nature of homogeneous catalysis in general.* Homogeneous catalysis was assumed to be of two and only two kinds: (1) *Chemical catalysis* and (2) *Physical or Medium or Solvent catalysis.*

A chemical catalyzer was conceived simply as a reagent, like those appearing in the stoichiometric equation, with this unessential difference, that while the stoichiometric reagents disappear in the course of the reaction, the chemical catalyzer disappears in one stage only to reappear in a later stage, the net result being the same as if it had not reacted at all; which, of course, creates a puzzle. For instance, in sugar hydrolysis the mechanism of the time-taking reaction doubtless consists in the formation of a complex made up of a molecule of sucrose, a molecule of water, and a hydrogen ion,—which complex instantly breaks up into glucose and fructose with the re-liberation of the ion. Without the acid ion the essential complex would not come into existence, and so there could be no inversion. The ion is, therefore, as essential a reagent as the sugar itself, and if it were not for its stoichiometric non-appearance there would be no need at all of labeling it with the mysterious name "catalyzer."

On the other hand, it has long been known that one

*J. Am. Chem. Soc., vol. 35, p. 173. See also, ibid., vol. 33, p. 1911, and vol. 35, p. 348.

and the same reaction, at one and the same temperature, will proceed with different velocities in different solvents. If the solvent causing a lower were gradually replaced by the one giving a higher velocity, the reaction velocity would gradually increase, and consequently the second solvent would have to be recognized as a catalytic agent. Conversely, if the second solvent were gradually replaced by the first, the reaction would be more and more slowed up, and the first solvent would have to be labeled as a *negative* catalyzer. Since the solvent presumably takes no direct part in the reaction, its catalytic effect must be recognized as something quite different from that of our "chemical" catalyzers. We named this phenomenon "medium catalysis," and we conceived its effect to depend upon the more or less pronounced dielectric character of the medium and its corresponding dissociating power, by which it would more or less effectively obstruct the formation of the molecular complex essential to the reaction. Thus, water—the best of dissociators—should be expected to act as a negative catalyzer. And it does. Benzol, one of the poorest dissociators, should be expected to have a positive catalytic effect, and in fact we found it to hasten our organic reactions considerably.

It will be seen that the elements of our working hypothesis were not very novel. Its value and novelty were chiefly in the idea that there was nothing *else* to homogeneous catalysis, that there were no *other* kinds of homogeneous catalysis, that therefore catalysis was not at all the dark mystery that it appeared to be. But if the entire value of our hypothesis lay in its limiting simplicity, its correctness could only be tested by quantitative experiments of the highest precision.

The mathematics of our first kind of catalysis, chemical catalysis, is comparatively simple. If the catalyzer is indeed a chemical reagent, then it must obey the law of mass action. And if a single hydrogen ion goes to form the active complex, and moreover the ion concentration remains constant during each hydrolysis, the reaction velocity should be strictly proportional to the hydrogen ion concentration. If experiment of precision shows it to be otherwise, then our working hypothesis is false, and it is powerless to shed light on the problem of catalysis. As a matter of fact, our uncommonly extensive study of inversion with acetic acid as a catalyzer showed the velocity to be uniformly and exactly proportional to the ion concentration,—as strictly proportional to this as to the concentration of the sugar itself. In addition, our unmistakable results in this case were corroborated by an equally precise study of the catalytic dissociation of tertiary amyl esters.

The quantitative behavior of our second kind of catalysis, namely medium catalysis, was unexpectedly found to follow the mathematical law of compound interest. If, namely, k is the velocity constant of the kinetic form of the mass law; k_0 the velocity coefficient of the same reaction if freed from the effect of medium; C_1, C_2, C_3, . . . the concentrations of the several ingredients of the medium; and k_1, k_2, k_3, . . . specific constants corresponding to those ingredients, then

$$k = k_0 e^{k_1 C_1 + k_2 C_2 + k_3 C_3 + \cdots}$$

This came as a surprise, for reasonable expectation was that consecutive additions of a solvent catalyzer would have a gradually attenuated effect. But, of course, in science, experiment is the last court of appeal.

If our findings are in time confirmed by further experimental studies of the same general character, then the veil will have been lifted at least from homogeneous catalysis.

◆

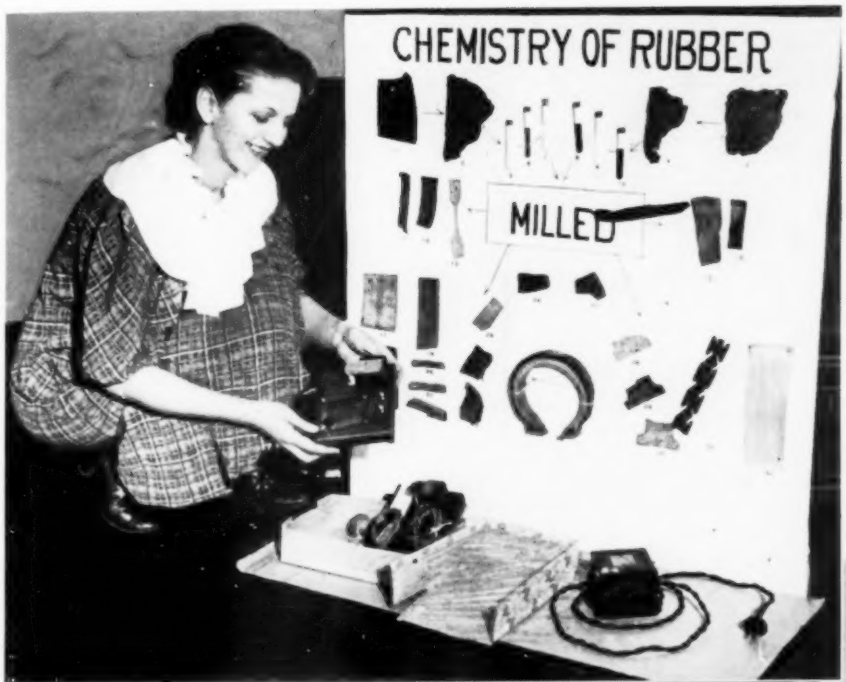
Transmutation and Nuclear Reaction

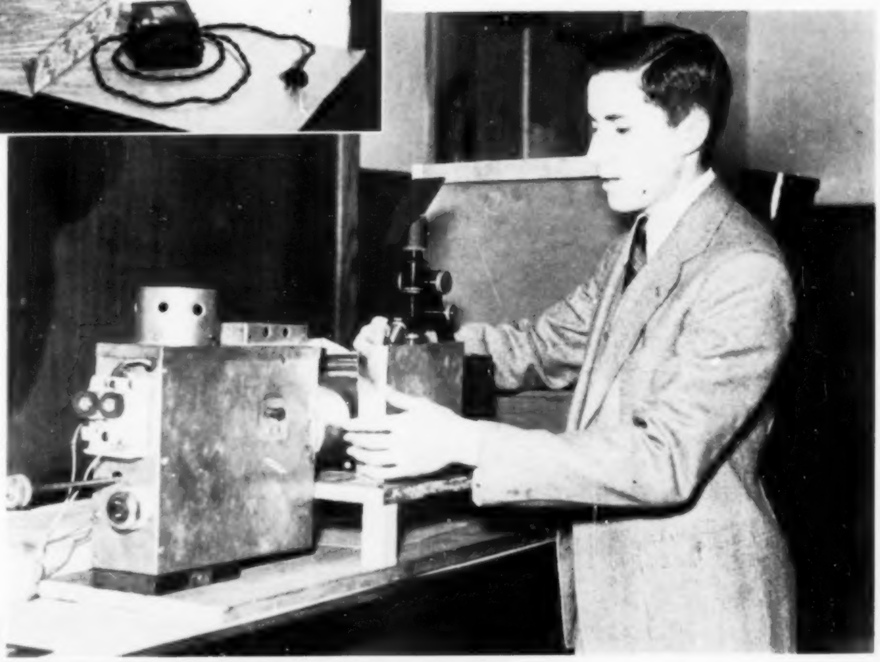
Transmutation, the dream of the medieval alchemist, is now fully realized. A large number of elements have been transmuted by bombardment of the nucleus of the atom with projectiles consisting of neutrons (uncharged particles), and protons, deuterons (nuclei of heavy hydrogen), and alpha-particles, the latter three being charged. Of these particles, the neutron is the most effective. The forty some elements known to have been transmuted by neutron-impact are distributed throughout the periodic table, while those known to have been transmuted by impacts of charged particles are solely elements of low atomic number. From experimental data on these phenomena, a new kind of chemistry has been developed, the chemistry of nuclear reactions. The nucleus is now known to be a structural unit. It is believed to consist of protons, antons (negative protons), and neutrons.

◆

List of Advertisers

High School Science Projects



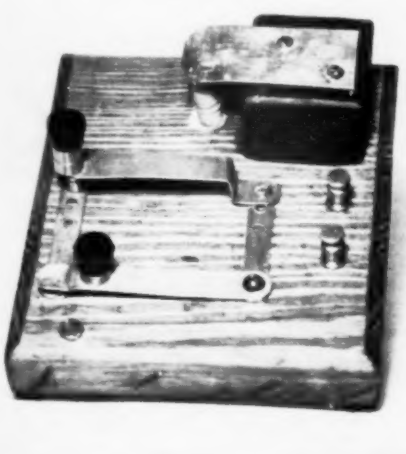


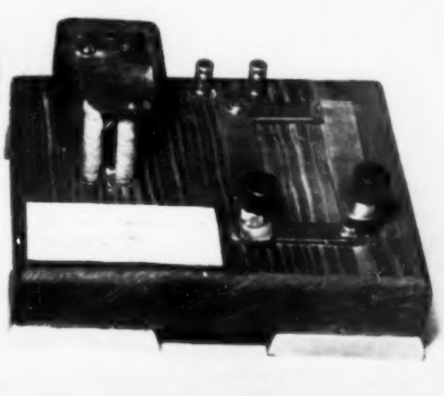
● ABOVE

A display of rubber prepared by students at the Notre Dame Academy, Cleveland, Ohio.

● RIGHT

A microprojector that really works! Built by Edmund A. Yochum of the St. Justin High School, Pittsburgh, and demonstrated at the recent Duquesne University Conference for Teachers of Science in the Catholic High Schools.





● LEFT

A receiving and sending telegraph set constructed by James English and Paul Schwabedissen, of the Saint Mary of the Mount High School, Pittsburgh.

You Should Read

The Discovery of the Elements

● *By* MARY ELVIRA WEEKS, Assistant Professor of Chemistry at the University of Kansas; Easton, Pennsylvania: Journal of Chemical Education, 1934. iii + 363 pp. 301 illustrations. $3.00.

This book, which is a collection of reprints of a series of articles first published in the Journal of Chemical Education, gives a connected story of the discovery of all the known elements. Beginning with the nine elements known to the ancient world, gold, silver, copper, iron, tin, lead, mercury, sulfur and carbon, elements whose discovery is shrouded by the mists of antiquity, the author gives a spirited account of the finding of the other elements, one by one, down through the years. The discovery of hafnium (1923), masurium (1925), rhenium (1925), illinium (1926), virginium (1929), and alabamine (1931) are related. Biographies of the discoverers of the elements are included.

Never before has the story of the elements been brought together in a single volume and told as a connected narrative. So well has the author done her work that the reader finds it difficult to put the book down before he has finished reading it all. It is an inspiring work. It will interest every high school student and teacher of science. It should appeal to the general public as well.

The book contains many interesting illustrations, an extensive bibliography, a chronological table of significant scientific events, and a satisfactory index.

J. F. M.

Science Teaching at Junior and Senior High School Levels

● *By* GEORGE W. HUNTER, PH.D., Lecturer in methods in education in science at the Claremont Colleges; formerly head of the department of biology at DeWitt Clinton High School, New York. New York: American Book Company, 1934. vii + 552 pp. $2.50.

Any man who has taught for thirty-five years knows a great deal about his job that he can, if he will, pass on to less experienced teachers to their great and lasting benefit. Every teacher of science, novice and expert, should be glad that Dr. Hunter has chosen to do so, for he has done his task exceedingly well. In a simple and direct way he discusses some of the things he has learned from his long experience, and in the narrative he embodies those recent findings in education that apply to the teaching of science below the college level.

Dr. Hunter covers satisfactorily the field he has marked out. He writes honestly. His book is practical and up-to-date. It is well written. It will be helpful not only to the beginner, but also to those teachers who may have been teaching for some time. Dr. Hunter is solicitous for the older teachers, feeling that they may need special help and guidance just at this time, so that they will not fail to understand and appreciate the changes that have been made within recent years in the teaching of high school science.

After considering the modern program of science teaching from the elementary school to the college, its development in the United States, and its proper objectives, the author treats of such topics as the scientific method, special science methods and technique, textbooks, motivation, visual education, and supervised study. He discusses health education, testing, the laboratory, classroom and library, and the preparation of the teacher.

The book contains a wealth of worth-while material. Each chapter is introduced by an interesting preview. Throughout the book numerous references are made to the literature. Study questions and reading references are included in every chapter. There is a good index.

No science teacher can read this book without having a clearer understanding of what he is trying to do; without being stimulated to become a more skilful instructor. Every teacher of science should add it to his library.

H. C. M.

Tours Through the World of Science

● *By* T. W. SKILLING, State Teachers' College, San Diego, California. New York: McGraw-Hill Book Company, 1934. xiv. + 758 pp. Illustrated. $1.70.

The twentieth-century high school student who is accustomed to tour the country by automobile, will be keenly interested in the "tours through the world of science" provided by this unusual textbook. The title is apt, for the subject matter of the book is divided into nineteen chapters or "tours," each marked by a route number of its own, and each mapping out a little journey into a special field.

The pleasant fiction of travel is maintained throughout the book. Sign-posts point out the territory to be covered. Each paragraph heading is considered to be a road-sign on the route. The interesting preview of each unit is headed "Where the path will lead." Then comes the "Preparation for the trip," which is a series of questions designed to recall previous information. At the end of each tour, in a "Telling others what you have seen" summary, the pupil is asked to report on the new things he has learned. Suitable questions for testing both memory and understanding are included. Each journey ends with suggestions for home projects that are designed to stimulate original investigation.

The book has been planned to cover the major fields of physical and biological science. The first trips are

Continued on Page Thirty-two

Have You Contacted Reality?

Continued from Page Twelve.

eye and a receptive mind. At every turn you wonder why your servant did not observe this phenomenon or report on that other. The road of necessity is a different sort of road to every one who travels it. And it is different because the mind that sees it is filled with varying sorts of information. The background of each observer varies from that of his companions. He can not view the road without fitting it into his background. That is why it is so important that he should see it himself. It is from his seeing it that his own original ideas are born. The more eccentric his background the more original his ideas will be. And, of course, the greatest eccentric of all is not the greatest lunatic, but the greatest scientist. The lunatic is a great eccentric because he is not limited by reality. The great scientist is a greater eccentric still because in another sense neither is he limited by reality. I mean he is least ignorant of reality, and therefore not limited by his ignorance of it.

Books are only a report on reality made by a messenger sent on the way. A man who brings only book knowledge to any scene dare not believe that he has any background of personal reactions to reality. Lacking such a background, his mind will probably be sterile even in the presence of the most startling manifestations of God's creative hand. Or if ideas arise within him at all, they will be the commonplace reactions that surge up within the ordinary man who has read the same books that he has read.

Reality thrusts itself sometimes too mercilessly into the face of every one who tries to act. The greater the number of acts, even though they result in failure, the greater the acquaintance with reality. But reality makes up only with those who act. It is a wall flower with those who will be wall flowers, too.

I think it will not be disputed that the essential qualification of a wall flower is lack of initiative. Lack of other natural endowments does not condemn any one to his prison cell along the wall, if initiative is there to defend him. But without initiative even the most gifted lack the personality they need to be attractive. Now reality has a way of concealing itself pretty completely from those who lack initiative. If you merely follow the directions of the text in conducting an experiment, you would know as much from the book without the experiment. Your departure from the book need not be great at first. If only you find some trifling thing that the author did not seem to observe you have been introduced by your initiative to reality.

How much initiative could be cultivated in the social

sciences I need not remark. How little it is cultivated needs even less proof. College men, surrounded by a laboratory of hundreds of thousands of sociological specimens in an industrial town, ignore their myriad opportunities of contacting reality and relegate the work to charitable societies and emergency relief organizations. Catholic college men, with a Catholic philosophy, a minority in a laboratory of false and extravagant beliefs, indifferently observe the hundreds of thousands of cases awaiting diagnosis and therapeutics, and relegate the task to specialists who will never have the opportunity they had. Contact with reality, I suppose, is too exacting. It is easier to read the report in a text. It is easier, too, to be standardized, mediocre, and stereotyped. So, if you are looking for comfort, pick out your groove. You can roll along with all the other balls that are going your way, and no one will ever know you passed.

Helpful Teaching Devices

Continued from Page Eleven

Where may suitable pictures be obtained? How are they mounted?

We obtained a number of pictures for our set from back numbers of the National Geographic Magazine. These prints can be purchased direct from the National Geographic Society at 48 for thirty cents. In larger numbers they are somewhat cheaper. Lists of the pictures available will be furnished by the society.

For mounting, a number of sheets of celluloid and a roll of one-inch binding tape are required. The celluloid cost us nothing, since we were able to obtain without cost from our hospital a large number of discarded X-ray negatives. We cleaned them carefully by soaking them for fifteen minutes in a strong solution of lye. The gelatine was then removed with a brush, and after rinsing them in clear water, the celluloid sheets were hung up to dry. The sheets were then cut to the required size. After placing a picture between two pieces of celluloid we bound all four edges with tape, and our picture was finished. Binding tape may be purchased, with or without adhesive, in a number of colors. Even the paper tape used by grocers for sealing packages can be employed.

The work of mounting requires no special skill, and it takes only a little time. Students like to help in preparing the pictures. They should be permitted to do so. The activities of the biology club, for example, might profitably include picture mounting of this type.

The teacher of biology who makes and files a series of these pictures for use in connection with her classroom work, has, at a trifling expense, a most valuable visual aid.

Most of the helium produced in the world comes from the gas wells of Texas.

Physics Notes

By **Roland Schaffert, Ph.D.**
(University of Cincinnati)

•

Protecting the Earth

The importance of the presence of water vapor in the atmosphere, because of its ability to absorb radiation from the sun, has been known for some time. It now develops that the presence of ozone is equally important. Ozone absorbs part of the ultra-violet of the sun's radiation, while water vapor absorbs some of the infra-red, or heat radiation. While a certain amount of ultra-violet and infra-red radiation are essential and beneficial to life, an overabundance of either or both can be equally harmful. The ozone layer of the upper atmosphere, and the water vapor of the lower atmosphere act as protective filters.

Electron Optics

A new branch of physics, known as "Electron Optics" is attracting attention at the present time. It deals with the effect of symmetrical electric or magnetic fields upon electron beams. Electrons are "refracted" by such fields in a manner similar to the action of lenses and prisms on beams of light, making it possible to focus the electron beams in various ways. The probability of using these principles in an "electron microscope" with enormous magnifying power was discussed in a paper presented at a recent meeting of the American Physical Society, by Dr. C. J. Davisson.

Artificial Radioactivity

The outstanding discovery of 1934, in the field of physics, according to the Physics Forum of the Review of Scientific Instruments is the discovery of "artificial" or "induced radioactivity" by the Joliots. In this phenomenon, particles impinging on nuclei are producing a transmutation which occurs in at least two stages. The first stage is the formation of a new and unstable nucleus, while the other is the spontaneous disintegration of this nucleus producing the same effect that is observed in radioactivity. What is detected is the emission of charged particles (negative electrons) when neutrons are the impinging particles, and positive electrons when the impinging bodies are alpha particles. Induced radioactivity may also be produced by impacts of protons and deuterons.

Have You Read?

Worth while articles in the current literature of Science

LIFE IN THE BIOLOGY LABORATORY, by Alfred F. Nixon, Dunbar High School, Washington, D. C., in *Science Education*, December, 1934.

A refutation of the idea that living biology cannot be taught in the high school laboratory. What one instructor did.

ECONOMY IN THE CHEMICAL LABORATORY, by Charles H. Stone, Boston, Mass., in *School Science and Mathematics*, January, 1935.

Ways of making the laboratory appropriation go further. A timely article for every teacher whose budget is limited or inadequate.

SULFUR, by William A. Cunningham, chemical engineer, San Angelo, Texas, in *The Journal of Chemical Education*, January, February and March, 1935.

All about sulfur.

DEMONSTRATIONS AS A SUBSTITUTE FOR LABORATORY PRACTICE IN GENERAL CHEMISTRY, by Herschel Hunt, Purdue University, in *The Journal of Chemical Education*, February, 1935.

A college study, but interesting to high school instructors.

INDOOR GARDENING, by Romaine B. Ware, in *Nature Magazine*, January, 1935.

How to grow plants on a small scale indoors.

THE PROJECT METHOD IN BIOLOGY, by Charles G. Smith, Hollywood High School, Hollywood, Cal., in *School Science and Mathematics*, January, 1935.

An investigation of the relative merits of the project method as compared with the traditional method of teaching biology in the senior high school. The writer finds that although the students prefer the project method, it does not seem to give as satisfactory results as the traditional method.

SCHOOLS OF CLOISTER AND CASTLE, by Charles A. Beard and William G. Carr, in *Journal of the National Education Association*, January, 1935.

Tracing the development of the schools through the Middle Ages and the Renaissance. Interesting reading, but you won't agree with all of it.

EINSTEIN'S THEORY IN WORDS OF ONE SYLLABLE *and* MILLIKAN'S COSMIC RAY TRUTHS in *Science News Letter*, January 5, 1935.

The titles are self-explanatory.

SOME PROBLEMS CONNECTED WITH A STRATOSPHERE ASCENSION, by Jean and Jeannette Picard, in *Industrial and Engineering Chemistry*, February, 1935.

How the difficulties of air conditioning, releasing ballast, gondola construction, and other problems were solved.

THE HUMANIZING OF SCIENCE, by Harvey Cushing, M.D., in *Science*, February 8, 1935.

"—I do not clearly perceive just where the humanities leave off and science in general begins, nor why in the schools any conflict should have arisen between them, for they spring from the same hellenic roots and seem so essentially supplementary."

The Teaching of Evolution

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that are the fruit rather of antitheological bias than of conscientious research. Only the scientific inquirer, who is cautious and sincere, is worthy of so high a prerogative as freedom.

For the rest, the God of Nature and the God of Revelation are one and the same God, and it is therefore impossible for science to discover in nature anything that contradicts His Revelation; if, then, "the vain appearance of such contradiction should arise, this is either because the dogmas of faith have not been understood and expounded according to the mind of the Church or because arbitrary opinion has been mistaken for a judgment founded on reason." (Vatican Council, *Const. de Fide Catholica*, cap. 4.)

Relation of Obscurantism to Fundamentalism

Thus from whatever truths the natural scientist may discover by observation, induction, and experimentation, the true religion has nothing to lose and everything to gain. "Never," says the Vatican Council, "can there be a real conflict between faith and reason." *(Ibidem.)* Obscurantism, therefore, that refuses to face facts, is a sign of weak faith and not a mark of orthodoxy. Nothing could be more fatuous or disastrous than such an attitude. "What will you say," wrote Galileo, "of the foremost teachers of the university of Padua who one and all declined my offer to show them the planets, the moon, and my telescope?" *(Letter to Kepler.)* We all know the sad consequences of that refusal.

When we go to the roots of the matter, we find that the obscurantist attitude among Catholics is commonly traceable to the influence of Protestant *fundamentalism*. From the very beginning Protestantism has regarded the Bible as a plain handbook of religion, absolutely foolproof and incapable of being misunderstood by anyone. This naturally commits the Evangelical to a consistent policy of literal interpretation, with all the crudities that such literalism involves. To him the reasonable Catholic attitude, which allows a certain leeway for figurative exegesis, is a veritable rock of scandal. He has always looked on this askance as one more instance indicating our disregard for the sacrosanctness of the Inspired Text.

Hence, whereas Pope Paul III accepted the treatise *De Orbium Celestium Revolutionibus* dedicated to him by the Catholic priest, Nicholas Copernicus, in 1543, Protestant Fundamentalism declared immediate war on the heliocentric theory. No sooner had Johann Kepler (1571-1673) begun to teach it in Germany than he became the victim of a Lutheran persecution headed by Melancthon himself.

This example of the Lutherans was unfortunately contagious. From Protestant Germany opposition to Copernicanism spread to Catholic Italy. Catholic theologians, anxious to show that they yielded nothing to Pro'estants in their zeal for the Scriptures, commenced to belabor Galileo Galilei with Ecclesiastes I, 4: *Terra in aeternum stat.* They failed to see in the text anything but the letter. *Stat* meant that the earth was *stationary;* it could not mean simply that the earth was *permanent.* They failed to remember what St. Thomas of Aquin had so wisely remarked about Ptolemaic astronomy: "But the hypotheses, which astronomers have devised, are not necessarily true . . . because stellar appearances may perhaps be accounted for on some other basis not yet understood by men." (lect. 17 in Aristotel. I, 2 *de coelo.*)

Everyone knows that the ensuing condemnation of Galileo and Copernicanism by the Congregations of the Index and the Inquisition represented only disciplinary decrees and not a dogmatic definition of the Church. Nevertheless, it is unfortunate that Catholics were not then as much on guard against the Protestant error of Fundamentalism as they are today.

Science and the Bible

Is it necessary to point out the moral? One cannot but see that, even assuming evolution to be a now-exploded hypothesis, it is a serious tactical blunder to oppose it with Scriptural texts. False science must be overcome by true science and not by citations from the Bible. Nearly a decade has passed since the last rout of Fundamentalism at the hands of "Modern Science." Disaster overtook the Round Head forces in Nashville, Tennessee. Thither they had marched, with the King James version as their Ark of the Covenant, and Bryan and the Rev. John Roach Stratton as their leaders, to do battle with the Philistines of science. They won the trial, but lost the argument; backed by applauding press men, the scientists captured their Bible and overwhelmed its quoters with denunciation and opprobrium. Conklin, the ex-ministerial zoologist of Princeton, and Osborn, the oracular palaeontologist of Columbia, poured out upon them the vials of their contempt; Bertrand Russell joined in the kill, shouting his *tally-ho* from across the sea—"So the Philistines fought . . . and Israel was overthrown . . . and the ark of God was taken." (I Kings, IV, 10,11.) Biblical inspiration, apparently, is not a very effective argument against infidel science. The latter must be met with the only weapons it respects, and not by urging an authority it does not recognize—"It is futile," says Aquinas, "to cite authority against those who do not accept authority." Conklin, surveying the Scopes trial from the heights he deemed impregnable, witnessed with unwrung withers the discomfiture of his erstwhile confreres. "It would be amusing,"was his comment, "if it were not pathetic, to see these 'defenders of the faith' beating their gongs and firing their giant crackers against the ramparts of science." (*Evolution and the Bible*, p. 24.) The catapulting of one or two well-aimed scientific facts would have done more to upset Conklin's smug complacency than a whole concordance of Biblical texts.

But, if it is a mistake to intrude Scripture upon the territory of natural science, it is no less a mistake to distort the sacred text by reading into it the viewpoint of modern science, even though one's motive be to rec-

Continued on Page Twenty-four

The Good Teacher:

- Answers, or at least acknowledges, the questions of his class. The teacher who pays no attention to a child with upraised hand is inexcusably discourteous.

- Asks himself habitually, "Is this the most efficient way of doing this particular thing?"

- Makes each lesson assignment clear, definite, and interesting.

- Creates in his laboratory a scientific atmosphere by the use of portraits of scientists, other pictures, models, drawings, charts, specimens, collections and other similar material. Much of it can be collected, drawn, or made by the students.

- Tries to develop mental aggressiveness in his pupils.

- Makes review less necessary by teaching each topic until the class *understands it.* He guards against mere memorizing. He varies his questions in many ways and asks the pupils to make applications not given in the textbook in order to make the class think. He uses every means to make sure the class *does* understand.

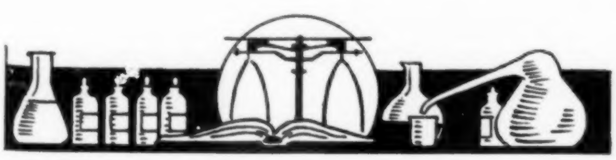
- Respects the intelligence of his pupils.

- Studies constantly in order to become better informed. As a consequence he becomes a more successful teacher. He handles his classes with less difficulty because, by studying, he retains the student point of view, a wholesome thing to do.

- Frequently recalls the old statement that a teacher has not really taught until the student has learned.

- Is business-like, for he realizes that teaching is a business. It is also an art. It is likewise a privilege.

Do You Do These Things?



The Teaching of Evolution

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oncile the twain. Indeed, had Galileo busied himself with accumulating genuinely scientific arguments for Copernicanism instead of trying to harmonize it with the Bible, there would have been no condemnation either of him or of the system he was defending. As Pope Leo XIII expresses it:

"There will be no real clash between the theologian and the natural scientist, so long as each confines himself to his own field, avoiding the fault St. Augustine warns against of rashly putting forth as known what is unknown. But if they do dissent, there is the general rule for theologians also laid down by him (St. Augustine): 'Let us show that whatever they (i.e. scientists) are able to demonstrate from the nature of things by means of sound arguments, is not contrary to our scriptures: but anything set forth in their books, which is contrary to our scriptures, that is, to the Catholic faith, let us either by some means show it to be utterly false, or believe it to be so beyond all doubt.' As regards the fairness of this rule, the first thing to consider is that the sacred writers, or to speak more precisely, 'the Holy Ghost who spoke by them, did not intend to teach men these things (to wit, the intimate nature of the things that constitute the visible universe), things in no way profitable to salvation'; hence they do not seek to explore the secrets of nature, but rather described and dealt with things in more or less figurative language, or in terms which were in common use at the time, and which in many cases are in daily use to this day, even by the most eminent men of science. Ordinary speech primarily and properly describes what comes under the senses; and somewhat in the same way the sacred writers—as the Angelic Doctor also reminds us—'went by what sensibly appeared,' or put down what God, speaking to men, signified in the way men could understand and were accustomed to." (*Providentissimus Deus*, 28.)

Concordism Obsequious and Anachronistic

Had the wise counsel of the Pontiff been heeded in our own day, we might have been spared (partially, at least) the humiliation of a sycophantic *concordism*, whose obliging exponents have striven to twist the first chapters of Genesis into a semblance of conformity with the modern geological time-table. The Concordists saw in the Six Days of Creation, not twenty-four hour periods but multimillion-year ages corresponding to the rock-groups and rock-systems of our present geological classification. The honest geologist knows only too well that his so-called periods are mere theoretical constructs whose time-value is purely hypothetical. The popular impression, indeed, is that the comparative age of the strata is determined on the basis of *superposition*, namely, upon the very credible assumption that overlying sediments were deposited later than underlying strata. The fact, however, is that the criterion of superposition is seldom available. Correlation on this basis is restricted to the relatively small areas of outcrop. To correlate the strata of widely separated regions, between which it is impossible to trace physical continuity of the strata (e.g. Europe and America), recourse must be had to another criterion, namely, to *index fossils*, i.e. to sundry types or groups of fossilized organisms said to be characteristic of the rocks of a certain age. In other words, the fossils are dated by the strata and the strata by the fossils—an obvious circle in proof! Unless the geologist proceeds on the mechanically-impossible assumption that the earth is a huge onion swathed with universal coats, that were deposited everywhere in the same regular sequence, how is it possible for him to distinguish a *geographical* from a *chronological* distribution of animals and plants in the lost perspective of a distant past? By what sign can anyone know that our failure to find two kinds of fossil animals or plants together in the same formation shows that each lived in a different age, when it may just as well mean that each lived in a different locality?

Geology is far too flimsy and irrelevant a basis to use for the interpretation of Holy Writ; in theology we can find a more satisfactory key. The purpose of the exordium of Genesis is evidently to proclaim the creation of the world by the One True God and to promulgate the institution of a new liturgical *Week*, whose days would not commemorate the seven planetary gods of the polytheistic Semites, but remind men henceforth that heaven and earth and everything in them were not gods but rather works of God, created by the *fiat* of His infinite power. Viewed in this light, the days of Genesis do not cease to be what they must have seemed to the eyes of ancient Israel—periods of 24 hours each—not geological epochs of unknown duration. Their interpretation no longer involves extorting from the ancient text dubious warrant for our modern mechanistic cosmogony—a downright anachronism that cannot fail to provoke ridicule on the part of the infidel —it becomes instead natural, intelligible, credible.

Patristic Evolution

The same principle applies to the writings of the Fathers. Canon Henri de Dorlodot (cf. *Darwinism and Catholic Thought*, 1922, 2nd Conf., pp. 80-87) and Rev. Ernest C. Messenger (cf. *Evolution and Theology*, 1932, pp. 40-55) seek to find justification for our present-day theories of organic evolution in the writings of St. Augustine and other Fathers. The kind they actually discover there does not measure up to modern specifications (as I formerly pointed out in *The Case against Evolution*—cf. reprint of 1933, pp. 74, 75). That, in fact, was instantly noticed by one of Father Messenger's critics, who wrote: "While it is exceedingly interesting to find that some sort of sanction is given to some sort of evolution by these writers (i.e. the Fathers), one does not read far without discovering that the author means by evolution something quite different from what the term suggests to most modern readers." (Cf. *Christian Century*, Mar. 9, 1932.)

Then, too, dragging the Scripture and the Fathers into the discussion of evolution creates the false impression that we are bound in conscience to adopt this mode of procedure; it is apt to attract unwelcome derision or pity, as the case may be, from persons who believe that the Catholic Church puts a quarantine on brains. Says another of Father Messenger's critics (in *The London Times*, Lit. Sup., Jan. 14, 1932, p. 31):

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"Dr. Messenger's frankness and fairness awaken sympathy in the difficulties which naturally arise where the text of the Vulgate and certain observations of the Fathers have to be treated as authorities to be considered in modern discussions." Once more, I repeat, let us refrain from injecting Bible and Fathers into a purely scientific discussion, and thus make it clear to all that, in the field of natural science, Catholics are objectivists and not authoritarians.

Does this mean that I advocate unquestioning acceptance of the dogma of evolution? Far from it! The test of a scientific hypothesis is its conformity to facts. Let us refuse, therefore, to subscribe to the present-day convention that evolution is to be leniently criticized, and proceed instead on the opposite assumption, namely, that what is offered as a genuine conclusion of natural science must be able to stand the acid test of merciless criticism.

In What Sense May Evolution Be Taught?

Evolution, we are assured by the Catholic biologist, E. J. Menge, is a *necessary hypothesis*—"all biological workers must accept evolution as a scientific hypothesis." (*Gen. & Profess. Biology*, 3 ed., 1928, v. I, p. 413). We have no quarrel with this statement, provided it really means evolution *as a hypothesis* and not evolution *as a fact* or even *as a theory*. Evolution is not a fact, because a fact is an *observed* event, and so far no man has ever been privileged to witness with his senses even so elementary a step in the evolutionary process as the actual origin of one species from another. Mendelian studies have destroyed the so-called experimental evidence for evolution; none of the products of mutation, hybridization, or polyploidy can be regarded as genuine new species.

Neither can evolution be termed a *theory* if by theory is meant a *verified* hypothesis. It has not been verified as a hypothesis *of law;* for a law of nature should be expressible in clear-cut, quantitative terms, whereas "biologists have not been able to formulate any definite quantitative or mathematical laws regarding a process of evolution. It is true that many attempts have been made in that direction but to no avail." (Giesen & Malumphy, *Backgrounds of Biology*, 1929, p. 155.) It has not been verified as a hypothesis *of cause;* for on the admission of evolutionists themselves the agencies and factors of the alleged evolutional process still remain utterly mysterious; Lamarck's *use* and *disuse*, Darwin's *natural selection*, De Vries' *mutation*—none of these qualify as causes of specific change.

To sum up: there can be no objection, whether scientific or theological, to the acceptance of organic evolution as a *working hypothesis;* a formula that summarizes sundry findings of comparative anatomy and embryology; a tentative explanation of biological data; in short, a convenient framework on which certain facts may be arranged. As such, we are entitled to make use of it, though we must never allow ourselves or our students to forget that it is nothing more than one possible interpretation of anatomical homologies and not a certain conclusion issuing with logical necessity from the facts themselves. Yet, before Catholic teachers embark on such a course, it would be well for them to take into consideration the conclusion reached by the great anatomist, Louis Vialleton (cf. his *Morphologie Generale*, 1924, p. 697.), that transformism has already outgrown its usefulness even as a working hypothesis and is now, in consequence, an obstacle to scientific progress, in that it distracts our interest from the all-important differences of organisms by focusing attention overmuch upon their less significant resemblances.

Human Evolution

From Darwin to Dewey, our materialistic monists have applied the doctrine of evolution to man no less than animals and plants; and to the human mind no less than the human body. To derive a man's spiritual soul from evolving matter is contradictory alike to reason and to faith. As to the evolutionary origin of the human body, one cannot consistently deny this and still uphold the probable force of the general arguments for evolution. Messenger undertakes to solve the resulting problem of reconciling with Catholic faith an evolutionary origin of man's body, in case science should succeed (as it is certainly trying hard to do) in establishing the bestial ancestry of the human body.

But the feat is far from being accomplished. Palaeontology knows of 30 genera of fossil lemurs and 18 genera of fossil apes, which might genealogically connect modern apes with their Tertiary predecessors, but it has yet to discover so much as a single fossil species, much less a fossil genus, intermediate between man as we know him and the as-yet-undiscovered Tertiary ancestor common to apes and men. Not even catastrophism can be invoked to account for this hopeless condition of affairs. Any catastrophe that could have destroyed all the human links must needs have swept away the ape links too. "Palaeontology," as Branco remarked, "tells us nothing on the subject—it knows no ancestors of man." *(Fossil Man.)*

The exact chemical structure of Vitamin B has been determined by Dr. Robert R. Williams. Synthesis should soon follow. A pure product will then be available, with a consequent definiteness in dosage that is now impossible. Absence of Vitamin B from the diet causes beri beri, a nerve disease rather common in the Orient.

Science Notes

A new X-ray machine has recently been devised that may do away with the use of radium in the treatment of cancer. It is still in the developmental stage. It is expected that treatment with it will be inexpensive and speedy.

Two mammoths, huge elephants now extinct that lived in the Pleistocene period, have recently been discovered in northern Russia. The animals had been frozen in the ice for centuries, and their hair and flesh were found to be in an excellent state of preservation.

The theory has long been held that there is a perfect balance between the amounts of oxygen and carbon dioxide produced by the breathing process of plants and animals. Dr. Henry Norris Russell, of Princeton University, says that an equilibrium between the two does not exist. Plants cannot keep up in the race of production because every year the rocks of the earth's crust as they weather, remove thousands of tons of oxygen from the air and tie it up permanently in chemical combinations. Dr. Russell calculates that our supply of oxygen will last for only *one billion years!*

The William H. Nichols medal of the New York Section of the American Chemical Society for 1935, has been awarded to Father Julius A. Nieuwland, C.S.C., professor of organic chemistry at the University of Notre Dame. This award, one of the highest honors in chemistry, was granted for basic work on synthesis from unsaturated hydrocarbons. Father Nieuwland's work dealt with the chemistry of acetylene and its derivatives, his discoveries leading to the subsequent development of synthetic rubber by the DuPont Company of Wilmington, Del. The medal will be presented on April 22 at the meeting of the American Chemical Society in New York.

The Nobel Prize in chemistry for the year 1934 has been awarded to Prof. Harold Clayton Urey, of Columbia University. The award recognizes his discovery of deuterium, or heavy hydrogen, an isotope of ordinary hydrogen having a higher atomic weight. When it is understood that all the several hundreds of thousands of known organic compounds containing hydrogen may have isomers con'aining heavy hydrogen, the possibilities opened up by this discovery seem almost without end. Dr. Urey is the third American chemist to be so honored. In 1914, the late Prof. Theodore W. Richards, of Harvard University, received the award in recognition of his work in determining atomic weights. The prize was given to Irving Langmuir in 1932, for his researches on adsorption.

The Empire State Building has been struck by lightning many times, but neither the building nor the people in it have been harmed. It is fully protected by its dirigible mooring-mast tip of steel and aluminum and by the bands of metal extending down its sides which conduct the lightning instantly into the ground.

The June Number

of the Science Counselor

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Professors Levine and Bauer of the Creighton University spent the summer of 1934 in Alaska making a study of certain groups of Eskimos. In the June number, Professor Charles W. Bauer relates the interesting story of

A Medical Expedition to Eskimo Land

and tells something of the purpose and extent of the project and what it accomplished.

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For years the valuable researches and the unusual accomplishments of Father Julius A. Nieuwland of the University of Notre Dame have been known to scientists, but it was not until his part in the successful synthesis of rubber was made known recently that the public became aware of this modest priest-scientist. Mr. George F. Hennion, instructor in organic chemistry at Notre Dame and a close friend of Father Nieuwland, contributes a timely article on

Father Nieuwland and His Work.

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Last summer the teachers of high school chemistry attached to the Pittsburgh Motherhouse of the Order of St. Francis outlined a chemistry syllabus for use in all the district high schools conducted by the Order. Their procedure and the results of their work are described by Sister Mary Margaret of the St. Augustine High School, Pittsburgh. The title of her article is

Preparing a Chemistry Syllabus.

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Teachers inexperienced in the work, undertake

The Purchasing of Laboratory Apparatus and Supplies

with reluctance, because they know so little about how it should be done. There are good ways and poor ways, right ways and wrong ways of going about it. Mr. J. O. Bengston, secretary of the Chicago Apparatus Company, discusses how purchasing should be done.

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Every high school can and should have an herbarium containing at least the plants to be found in the neighborhood of the school. The work is not difficult. In a practical paper entitled

Making an Herbarium

Harold W. Werner, professor of botany at Duquesne University, advises the beginner how to proceed.

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Science Courses in Summer Schools will inform the readers of *The Science Counselor* what courses in science and in science teaching methods are to be offered during the summer of 1935 in the Catholic colleges and universities east of the Mississippi. This information should interest every teacher of science.

An Amateur Looks at the Stars

Continued from Page Six.

As the grinding proceeds, the thick upper or mirror disk becomes concave and the thinner under disk, called the "tool," becomes convex. The tool is later discarded.

An elaborate work bench is not needed, but it must be firm. Sister Cornelia used a flour barrel partially filled with rocks. This serves admirably, for it is necessary for the operator to circle around the work continually. The lower disk or tool is fastened firmly to the top of the barrel and coarse abrasive powder, about Number 80, and water, are spread over it. Then the operator begins to grind. Straight, short, over-and-back strokes are used, the mirror disk moving over the tool so that about one-third of the mirror's surface overhangs the edge of the tool at the end of the stroke. After every few strokes the mirror is rotated a bit in the operator's hands; the operator meanwhile progresses slowly about the barrel. As the grinding proceeds, successively smaller sizes of carborundum are applied in order to make the glass wear evenly. Following 80, numbers 120, 180, 300, and 600 are used in turn, each being used long enough to remove the scratches and pits made in the glass by the coarser grade previously used. A one-inch lens is used to detect such imperfections. The grinding is finished with Nos. 400 and 600 "aloxite."

The grinding continues until a depth of about 1/20 of an inch is reached in the center of the mirror. The form will be nearly spherical. Its curvature is measured repeatedly by an easily constructed template. If the curvature is found to be too great, the grinding stroke is shortened; if the curvature is too small, the stroke is lengthened. When the required curvature has been reached, the grinding is finished and the polishing begins.

Melted pitch is poured over the tool. As it hardens the concave side of the wetted mirror is pressed down upon it, pains being taken to insure good contact between the two surfaces. The mirror is then removed, and parallel channels about an inch apart are cut at right angles into the hardened pitch. "Air float" jewelers' rouge and water are applied and polishing begins. The same stroke is used as in grinding, and the work goes on for several hours. When the polishing is nearly finished, the spherical surface of the mirror is changed to a paraboloidal form by deepening it slightly toward the center. This can be accomplished by using somewhat longer strokes.

Progress is slow, for frequent and careful testing of the curvature is necessary. The Foucalt lamp and knife-edge method is used. This surprisingly simple test is capable of detecting variations of a millionth of an inch. At last the operator is satisfied. The mirror is silvered in a few minutes by the Brashear process which uses rock candy to reduce an alkaline solution of silver nitrate. The mirror is then dried, polished and coated with water-thin clear lacquer.

An experienced workman should spend about five hours in grinding a six-inch mirror, and possibly twice as long in polishing it. Sister Cornelia has ground and polished a second mirror in twenty hours, but her first attempt required some eighty hours of labor. As might be expected, she encountered the usual troubles of a beginner. In the early part of the work she accidentally reversed the positions of the tool and the mirror. The two disks became flat again. All her work was lost. Once she turned the wrong face of the mirror against the tool. Again, after six hours of polishing, she discovered a scratch that required more than fifteen hours of labor to erase.

Other difficulties were met. The work of polishing and testing must be done in a room that has an even temperature. There should be no dust in the air. Even the air currents caused by a person passing by, interfere with the testing of the mirror. Consequently, some amateurs find it necessary to work in a cellar behind locked doors.

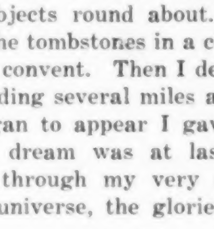
Once the mirror is polished and silvered, it is handled with much care. It is fastened securely to a wooden block and then inserted in the lower end of the telescope tube. The reflecting prism and the eye-piece are adjusted, the finder attached, and the telescope is finished. It is a big moment.

Sister Cornelia describes it: "I was too impatient to wait until evening to test the telescope, so I focused it on various objects round about. First I read the inscriptions on the tombstones in a cemetery situated on a hill facing the convent. Then I detected a number of defects in a building several miles away. Just as soon as the stars began to appear I gave the telescope its final test. My dream was at last realized when I viewed clearly, through my very own telescope, the marvels of the universe, the glories of the stars."

The book, "*Amateur Telescope Making*," edited by A. G. Ingalls, and published by the Scientific American Publishing Company, is recommended to those who may become interested in this work. It is a mine of practical information and makes clear many points that of necessity could not be discussed here.

Men, Mirrors and Stars, by G. Edward Pendray, science editor of the *Literary Digest*, is just off the press. It contains an excellent history of the development of the telescope and an outline of astronomy. It is well illustrated.

Such questions regarding telescope building as may be submitted to *The Science Counselor* will be referred for answer to Sister Cornelia and Messrs. Scanlan and Schoenig.



What Do You Think?

For discussion in your faculty group

I. Many of the pupils in Sister Mary Angela's class in general science protest that her assignments for home study are too long and too difficult. She is an experienced teacher. What consideration should be given to the pupils' complaints?

◆

II. A teacher in charge of a biology class says: "My pupils do not seem to study. They don't accomplish anything. They don't know how to use a textbook. They can't distinguish between the important and the unimportant parts of a paragraph. I don't know what to do."

◆

III. A young teacher is discouraged. She complains to the teacher of English that her pupils are finding their new textbook in physics too difficult because they can't understand it. Technical terms do not seem to bother them. The teacher of English says: "Have you ever tried having your pupils keep a vocabulary note book?"

◆

IV. Sister Mary Bernadine says of her new chemistry class: "They seem to understand my demonstrations. They answer my questions intelligently, but their notebook records are hopelessly bad. They don't separate procedures and observations, many points are overlooked, and their conclusions are not accurately stated."

◆

V. An experienced educator maintains that textbooks in high school science are written to fit the requirements of the big city schools where the greatest sales are to be expected. Little attention is given to the needs of the schools in smaller places.

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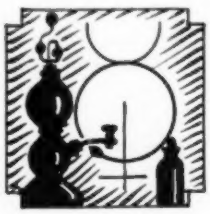
The names of teachers who submit satisfactory solutions to the foregoing problems will be published in the June number of the Science Counselor.



Physiology in the Secondary Schools

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who now commonly study physiology as a part of biology early in their high school course. With mature students, the subject of reproduction, usually considered untouchable, can be handled by the competent teacher in a serious, capable, and satisfactory manner. There should be no timidity, no embarassment in discussing it. False standards and prudery have shrouded the process of reproduction in mystery, secrecy and deceit. Certainly, here is a place where the religious teacher can instruct to much better advantage than the layman. There can be no sympathy for, and no desire to emulate, the recent Mexican official innovation of enforced sex-instruction for children, but some instruction by properly qualified persons can well be given.

It is true that parents have a certain responsibility for such teaching as may be necessary. Not all parents, however, accept the responsibility. One mother enlightened a certain juvenile curiosity, evidenced at an early age, by reciting the Ave Maria. The word "womb" must be very puzzling to little folks, inquisitive by nature as they are. This she reverently explained as the place close to the mother's heart where little babies are carried until they are born. She pointed out how very sacred these organs are because they bring into existence little babies with their precious souls. That satisfied the child for the time.

To explain the process of reproduction scientifically is not difficult. We shall begin with the maturing of the egg cell (the ovum or female element), and of the sperm cell (the male element). During the process of maturation the number of chromosomes typical of the cell of the species (48 in the case of man) is reduced one-half. The matured egg cell is expelled from the sex gland (ovary or female gonad) during ovulation, which occurs at the mid-menstrual period. This is the time of greatest probability for fertilization to take place. The matured expelled ovum, after traveling for a short time in the abdominal cavity, enters the Fallopian tube on its way to the uterus or womb. In the tube fertilization takes place if one of the many hundreds of thousands of matured sperm cells meets the egg cell and penetrates it. The two half-nuclei unite and the regular number of chromosomes, 48, is restored. Half of these, however, now are maternal and half paternal. In this way parental traits are transmitted. When fertilization has taken place, the lunar monthly period of menstruation ceases throughout pregnancy and during the lactation or feeding period. If fertilization does not take place, the ovum shortly dies, since it cannot propagate itself, and is expelled. Just before and just after the menstrual flow, is considered to be the period of the greatest possibility of sterility.

The fertilized egg cell drops down into the uterus and embeds in the uterine wall, forming an attachment known as the placenta, which is to serve as a medium for the exchange of materials between mother and fetus. The fertilized ovum at once begins to divide progressively into two, four, eight, sixteen, etc., cell states and assumes the shape of a solid ball (the mulberry or morula state). This becomes unwieldy and hollow in the center (the blastula stage); and finally, one side caves in or invaginates, and the gastrula stage is assumed. Eventually there is complete collapse like a deflated rubber ball. The wall thickness represents three important structures. The exterior of the ball, the ectoderm, gives rise to the epidermis and the nervous system; the middle layer, made up of the inside surfaces of the original hollow ball, gives rise to the skeleton, muscles, gonads (sex cells) and kidneys; while the inner surface of the collapsed ball gives rise to the respiratory tract, the digestive tube, the liver, pancreas, and other organs.

Building materials, oxygen and food, are received by the fetus through the placenta, and carbon dioxide and waste materials are given off by osmosis to the mother. The circulatory systems of mother and child are entirely independent. In the placenta they lie close together in finger-like processes known as villi. There is no actual end-to-end connection between the two systems. The fetal heart beat is independent, about 150 per minute; the rate increases if the babe is in distress.

The further embryology of this wonderful process is an intricate series of invaginations and evaginations (outgrowths). At the end of ten lunar months (about nine calendar months) the child is born. It is a matter of deep significance that it has always been believed, even by the early Fathers of the Church, that the soul of the new individual has its beginning at the instant of conception, that is, at the moment of fertilization of the ovum by the sperm cell; or, to be more technical, at the instant of the fusion of the two half-nuclei.

Should the teacher not feel competent to impart information of this sort to her class, the pastor will usually be able to obtain the services of an able Catholic physician who will be glad to give suitable health talks to the various classes.

MINIMUM REFERENCE WORKS FOR A WORKING LIBRARY

A Test Book of Physiology for Medical Students and Physicians.
William H. Howell. W. B. Saunders Co., Philadelphia, Pa.

The American Pocket Medical Dictionary.
Dorland. W. B. Saunders Company.

Human Physiology.
Percy Goldthwait Stiles. W. B. Saunders Company.
This easily readable, non-technical book is an excellent textbook.

Elementary Manual of Physiology.
Russell Burton-Opitz. W. B. Saunders Company.

Textbook of Physiology.
William D. Zoethout, S.J. C V. Mosby Company.

Laboratory Experiments in Physiology.
Zoethout. C. V. Mosby Company.

The Law of Living Things.
Edward J. Menge. Bruce Publishing Company.
An able presentation of elementary biology, including some physiology, hygiene, first aid, and a chapter of Evolution.

General and Professional Biology.
Edward J. Menge. Bruce Publishing Company.
Two volumes: Vol. I.—General Biology. Vol. II.—Introductory Embryology and Comparative Anatomy.

You Should Read

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taken in physiography. The earth, sea, air, water and rocks and minerals are considered. Then come astronomy and a rather brief discussion of the chemistry of common things. Units in physics study machines, engines, electricity, radio, sound, light and heat. The later chapters deal with plant and animal life, food, the body and its care, and with the lower forms of life.

Each tour is amply illustrated. The pictures are well chosen, the diagrams are clear, and the legends are good. The language of the text is non-technical and well adapted to the junior high school student.

Taken as a whole this textbook is an excellent one. It succeeds in placing modern science before the youthful student in a manner that is new, interesting, and pedagogically sound. *W. S.*